

Predicting Incidence of Long-term Care Insurance Certification in Japan with the Kihon Checklist for Frailty Screening Tool: Analysis of Local Government Survey Data

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Abstract

Background

Predicting incidence of long-term care insurance (LTCI) certification in the short term is of increasing importance in Japan. The present study examined whether the Kihon Checklist (KCL) can be used to predict incidence of LTCI certification (care level 1 or higher) in the short term among older Japanese persons.

Methods

In 2015, the local government in Tokyo, Japan, distributed the KCL to all individuals older than 65 years who had not been certified as having a disability or who had already been certified as requiring support level 1–2 according to LTCI system. We also collected LTCI certification data within the 3 months after collecting the KCL data. The data of 17785 respondents were analyzed. First, we selected KCL items strongly associated with incidence of LTCI certification, using stepwise forward-selection multiple logistic regression. Second, we conducted receiver operating characteristic (ROC) analyses for three conditions (1: Selected KCL items, 2: The main 20 KCL items (nos. 1–20), 3: All 25 KCL items). Third, we estimated specificity and sensitivity for each condition.

Results

During a 3-month follow-up, 81 (0.5%) individuals required new LTCI certification. Eight KCL items were selected by multiple logistic regression as predictive of certification. The area under the ROC curve in the three conditions was 0.92–0.93, and specificity and sensitivity for all conditions were greater than 80%.

Conclusions

Three KCL conditions predicted short-term incidence of LTCI certification. This suggests that KCL items may be used to screen for the risk of incident LTCI certification.

Background

The long-term care insurance (LTCI) system was introduced in Japan in the year 2000 to support people with disabilities via social security expenses.¹ The number of LTCI certifications in Japan is estimated to reach 9.88 million (8.9% of the total population) by 2040, a figure that is approximately double that of 2010.² Increasing social security expenses represents a serious future issue.³

The LTCI system in Japan provides people with services according to certification as one of seven levels (support levels 1–2 and care levels 1–5) depending on their disease condition or functional ability. People with support level 1–2 can receive preventive service, as may people who are not certified as having a disability.¹ To assess whether a person is eligible for preventive services or LTCI services, use of the Kihon Checklist (KCL) has been recommended by the Ministry of Health, Labour and Welfare, of Japan.⁴ The KCL is a screening tool developed in Japan for use with elderly people with frailty.⁵ It is used by local governments and in community consultations to screen for persons eligible for long-term care prevention programs and to assess the effectiveness of interventions. The KCL consists of 25 items; it requires approximately 15 minutes for an elderly person to answer all items.⁶

In Japan, LTCI certifications are determined at the Municipal Certification Committee, based on the assessment of the degree of functional disability using a questionnaire developed by the Ministry of Health, Labour and Welfare and reference to the “Doctor’s Opinion Paper” prepared by the attending physician.¹ There is a cost of 10,000 to 20,000 Yen per applicant associated with determining LTCI certification at the Municipal Certification Committee.⁷ However, if preventive services were provided to applicants who are not assessed as requiring care level 1 or higher based on KCL screening, the costs of unnecessary certification would reduce. One preventive service (service “C”) aims to gain intensive improvement over a short term of 3 to 6 months; the service program is reviewed a minimum of 3 months after onset.⁴ Therefore, to reduce social security expenses, it is necessary to use the KCL to determine persons who will likely change their care needs to care level 1 or higher in a short term of 3 months.

Previous studies have shown that each item and the seven domains of the KCL are associated with incidence of LTCI certification.^{8–13} One study reported that each domain of the KCL was useful for predicting the occurrence of LTCI certification (support level 1 or higher) in the subsequent year; the main 20 items of the KCL (nos. 1–20) had the greatest predictive ability.⁹ Another study reported that the nutrition domain, memory domain, and mood domain of the KCL were associated with 2-year incidence of LTCI certification (care level 2 or higher).¹⁰

However, these studies examined the association between the KCL and incidence of LTCI certification over more than a 1-year period; to the best of our knowledge, the ability of the KCL to predict incidence of LTCI certification in the short term has not been reported. Moreover, it would be useful to be able to predict incidence of LTCI certification using a subset of KCL items focused on practical situations.

Accordingly, the present study examined whether the KCL can be used to predict incidence of LTCI certification (care level 1 or higher) in the short term. To do so, we compared the utility of different KCL items for predicting incidence of LTCI certification during a 3-month period, among the different item sets, using a large dataset collected by a local government in Japan.

Methods

Participants

We used KCL data that were collected by the local government in Tokyo, Japan, in May 2015 to screen for frail elderly persons. The KCL was distributed by mail to 26630 individuals older than 65 years who were not certified as with a disability or with LTCl support level 1–2; the data of 17785 individuals (66.8%) who provided responses were analyzed. The ethics committee of the Tokyo Metropolitan Institute of Gerontology approved the present study. We explained in writing to the local government the purpose of the present study and how the results would be disseminated, and we obtained written consent to use the data.

KCL at baseline

The KCL consists of 25 self-report (yes/no) questions that assess seven domains: instrumental activities of daily living, physical strength, nutrition, oral function, isolation, memory, and mood.⁵ The main 20 items of the KCL (nos. 1–20), which are often used as the overall score of frailty, include six domains and exclude a mood domain.⁸ Responses are summed to obtain a KCL score for each participant. A higher KCL score indicates a higher risk of frailty.

Follow-up (incidence of LTCl certification)

Combined anonymized data on both the KCL and incidences of LTCl certification in the three months after collecting the KCL data were retrieved from the local government. Incidence of LTCl certification was defined as care level 1 or higher.

Statistical analysis

First, we used stepwise forward-selection logistic regression analysis, adjusting for sex and age, and using all 25 items of the KCL as explanatory variables to determine KCL items that were strongly associated with incidence of LTCl certification. We conducted receiver operating characteristic (ROC) analyses to calculate the area under the curve (AUC) and 95% confidence intervals for incidence of LTCl certification for following three conditions: i) KCL items selected based on the regression analysis described above, ii) the main 20 items of the KCL (nos. 1–20) which had better predictive utility based on previous study,⁹ and iii) all 25 items of the KCL. We additionally conducted a five-fold cross validation test for the selected items of the KCL. We created five data sets by randomly splitting all of the data into a training set and a test set with the ratio of 70%–30%, and estimated the accuracy of predicting incidence of LTCl certification. Third, we estimated the specificity and sensitivity for incidence of LTCl certification in each condition, based on the Youden Index value.^{14, 15} All data were analyzed using SPSS Statistics 23.0 (SPSS Inc., Chicago, IL, USA). All statistical tests were two-sided, and differences at $P < 0.05$ were accepted as significant.

Results

Population characteristics

The study population comprised 7827 men (44.0%) and 9958 women (56.0%), with a median age of 74 years (range: 65–107 years). During the 3-month follow-up, 81 persons (0.5%) required new LTCl certification.

Selected KCL items

Table 1 shows the eight KCL items that were selected using the regression, and sex- and age-adjusted odds ratios (ORs) and confidence intervals (CIs) of incidence of LTCl certification for each item. The selected eight KCL items included three items from the instrumental activities of daily living domain, one item from the physical strength domain, one item from the nutrition domain, one item from the memory domain, and two items from the mood domain.

ROC analysis

The AUC of the selected eight KCL items was 0.93 (95% CI 0.90–0.96), which was the highest of the three conditions (Figure 1). The AUCs of the main 20 items and all 25 items were 0.92 (95% CI 0.88–0.95) and 0.92 (95% CI 0.89–0.95), respectively. The five-fold cross validation test for the selected eight items indicated that the average AUC of the five training sets was 0.94, and that of the five test sets was 0.92.

Specificity and sensitivity

The optimal cut-off points determined by the Youden Index were $\geq 3/8$ for the selected eight items (specificity 82.1%, sensitivity 92.6%), $\geq 8/20$ for the main 20 items (specificity 89.7%, sensitivity 82.7%), and $\geq 9/25$ for all 25 items (specificity 85.1%, sensitivity 87.7%; Table 2).

Discussion

In the present study, we investigated that whether the KCL can be used to predict incidence of LTCl certification (care level 1 or higher) in the short term. Eight KCL items that were strongly associated with LTCl certification included three items from the instrumental activities of daily living domain, one item from the physical strength domain, one item from the nutrition domain, one item from the memory domain, and two items from the mood domain. The AUC of these eight items with respect to incidence of LTCl certification was 0.93, which was as high as that of the main 20 items and all 25 items. This result suggests that the eight items sufficiently predicted short-term incidence of LTCl certification.

There was likely no significant difference in the age distribution of the participants in the present study and overall elderly population in Japan because we used large-scale data from complete enumeration obtained by the local government.¹⁶ Moreover, the proportion of participants with LTCL certification (support level 1–2) at baseline was comparable to that of the whole Japanese population;^{16, 17} thus, the data in the present study were representative of community-dwelling Japanese elderly. Tomata⁹ reported that the 2.2% of individuals required new LTCL certification (care level 1 or higher) during a one-year follow-up, versus 0.5% during a three-month follow-up in the present study; the latter value might have been affected by the shorter follow-up period.

Tomata reported that the items of the KCL that were associated with 1-year incidence of LTCL certification (support level 1 or higher), through forced-entry logistic regression analysis, were two items from the instrumental activities of daily living domain, two items from the physical strength domain, one item from the nutrition domain, one item from the isolation domain, and two items from the cognitive function domain.⁹ In addition to these items, items from the mood domain were selected in the present study. Fukutomi reported no association between the mood domain and two-year incidence of LTCL certification (support level 1 or higher).¹¹ However, Hamazaki reported a significant association between the mood domain and two-year incidence of LTCL certification (care level 2 or higher).¹⁰ Therefore, items of the mood domain might be associated with short-term and more severe need for LTCL certification.

The utility of KCL items for predicting incidence of LTCL certification in the present study was notably greater than that reported in previous studies: The AUC in ROC analysis was 0.62–0.83 in Tomata et al.⁹ and 0.78 in Tsuji et al.¹³ The present study focused on the need for LTCL certification at care level 1 or higher over a shorter follow-up period than that in previous studies; the results suggested that the KCL was useful for predicting incidence of LTCL certification in the short term. Moreover, we found that the eight selected items were as efficacious for predicting incidence of LTCL certification as were the main 20 items and all 25 items. This result was also confirmed by a five-fold cross validation test.

The specificity and sensitivity for incidence of LTCL certification based on the selection criteria of the LTCL for people at high risk were 57.8% and 73.5%, respectively, according to national research in Japan, and 63.4% and 78.1%, respectively, in Tomata et al.⁹ Moreover, specificity and sensitivity were 73.1% and 70.5%, respectively in a previous study that used part of the KCL.¹³ Specificity and sensitivity in the present study were both more than 80%, values higher than those reported in previous studies.

In the present study, sensitivity using the eight selected items was highest at 92.6%, using a cut-off point of $\geq 3/8$ items; however, specificity was highest at 91.3%, using a cut-off point of $\geq 4/8$ items. These results suggest that it might be useful to change the cut-off point of the eight selected items according to various situations. The $\geq 3/8$ cut-off point might be recommended if fewer false negatives are required during primary screening, while the $\geq 4/8$ cut-off point might be recommended if fewer false positives are required during medical examinations.

From the results of the present study, if the local government did not determine LTCL certification at Municipal Certification Committees for service applicants with support level 1–2 based on the KCL, this would be expected to reduce social security costs by 6 billion Yen per year, given a cost of 10,000 Yen per person to determine LTCL certification at the Municipal Certification Committee.^{7,18}

The present study had several limitations. We used data that were collected by the local government to screen for elderly persons with frailty; however, the response rate was 66.8%. Thus, the study population might not have included people at higher risk of incidence of LTCL certification. Because not all participants eligible for LTCL certification actually apply for LTCL certification, the present study might have included detection bias. Since we did not investigate disease and functional ability, how health status affected LTCL certification was unclear.

In conclusion, the present study showed that the main 20 items and all 25 items could be used to predict incidence of LTCL certification during a subsequent 3-month period with high accuracy. Moreover, eight selected items of the KCL also could be used to make this prediction. Therefore, the items of the KCL that are included could be changed according to various situations when predicting short-term incidence of LTCL certification.

Abbreviations

LTCL: Long-term care insurance; KCL:Kihon Checklist; ROC:Receiver operating characteristic; AUC:Area under the curve; OR:Odds ratio; CI:Confidence interval; BMI:Body mass index

Declarations

Ethics approval and consent to participate

Ethical approval for the study was granted by the ethics committee of the Tokyo Metropolitan Institute of Gerontology (Acceptance no. 4, 2018).

Consent for publication

Not applicable.

Availability of data and materials

The data of this study cannot be released publicly due to ethicolegal restrictions imposed by the Ethics Committee at Tokyo Metropolitan Institute of Gerontology. Datasets generated may be available from the corresponding author on reasonable request, after ethical considerations.

Competing interests

The authors declare that they have no competing interests.

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No funding was received for this study.

Authors' contributions

K.I., H.K. and S.O. conceived and designed the experiments. K.I., H.K. and S.O. performed the experiments. K.I. analyzed the data. K.I. and H.K. wrote the paper. H.T. verified the analytical methods. All authors discussed the results and contributed to the final manuscript.

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Tables

Table 1. Association between the selected eight Kihon checklist items and incidence of long-term care insurance certification (n = 17785).

	Incidence of long-term care insurance certification			ORs (95% CIs) *
	n	Case	(%)	
1. Do you go out by bus or train by yourself?				
Yes	16593	30	(0.2)	1.00 (reference) †
No (positive)	1192	51	(4.3)	3.41 (1.96 - 5.92)
2. Do you go shopping to buy daily necessities by yourself?				
Yes	16764	37	(0.2)	-
No (positive)	1021	44	(4.3)	-
3. Do you manage your own deposits and savings at the bank?				
Yes	16280	37	(0.2)	1.00 (reference)
No (positive)	1505	44	(2.9)	2.54 (1.50 - 4.28)
4. Do you sometimes visit your friends?				
Yes	12537	10	(0.1)	1.00 (reference)
No (positive)	5248	71	(1.4)	3.59 (1.74 - 7.44)
5. Do you turn to your family or friends for advice?				
Yes	15194	31	(0.2)	-
No (positive)	2591	50	(1.9)	-
6. Do you normally climb stairs without using handrail or wall for support?				
Yes	12348	13	(0.1)	1.00 (reference)
No (positive)	5437	68	(1.3)	3.01 (1.58 - 5.72)
7. Do you normally stand up from a chair without any aids?				
Yes	15370	30	(0.2)	-
No (positive)	2415	51	(2.1)	-
8. Do you normally walk continuously for 15 min?				
Yes	16350	35	(0.2)	-
No (positive)	1435	46	(3.2)	-
9. Have you experienced a fall in the past year?				
No	14205	35	(0.2)	-
Yes (positive)	3580	46	(1.3)	-
10. Do you have a fear of falling while walking?				
No	10893	14	(0.1)	-
Yes (positive)	6892	67	(1.0)	-
11. Have you lost 2 kg or more in the past 6 months?				
No	14944	45	(0.3)	1.00 (reference)
Yes (positive)	2841	36	(1.3)	1.71 (1.06 - 2.76)
12. If BMI is less than 18.5, this item is scored.				
No	15872	57	(0.4)	-
Yes (positive)	1913	24	(1.3)	-
13. Do you have any difficulties eating tough foods compared to 6 months ago?				
No	13805	39	(0.3)	-
Yes (positive)	3980	42	(1.1)	-
14. Have you choked on your tea or soup recently?				
No	13965	50	(0.4)	-

Yes (positive)	3820	31	(0.8)	-
15. Do you often experience having a dry mouth?				
No	13349	46	(0.3)	-
Yes (positive)	4436	35	(0.8)	-
16. Do you go out at least once a week?				
Yes	16686	53	(0.3)	-
No (positive)	1099	28	(2.5)	-
17. Do you go out less frequently compared to last year?				
No	13959	25	(0.2)	-
Yes (positive)	3826	56	(1.5)	-
18. Do your family or your friends point out your memory loss?				
No	16113	47	(0.3)	-
Yes (positive)	1672	34	(2.0)	-
19. Do you make a call by looking up phone numbers?				
Yes	15967	43	(0.3)	1.00 (reference)
No (positive)	1818	38	(2.1)	2.10 (1.29 - 3.42)
20. Do you find yourself not knowing today's date?				
No	14766	41	(0.3)	-
Yes (positive)	3019	40	(1.3)	-
21. In the last 2 weeks have you felt a lack of fulfilment in your daily life?				
No	14762	32	(0.2)	-
Yes (positive)	3023	49	(1.6)	-
22. In the last 2 weeks have you felt a lack of joy when doing the things you used to enjoy?				
No	15848	29	(0.2)	1.00 (reference)
Yes (positive)	1937	52	(2.7)	3.21 (1.88 - 5.48)
23. In the last 2 weeks have you felt difficulty in doing what you could do easily before?				
No	13134	21	(0.2)	-
Yes (positive)	4651	60	(1.3)	-
24. In the last 2 weeks have you felt helpless?				
No	14356	26	(0.2)	1.00 (reference)
Yes (positive)	3429	55	(1.6)	1.90 (1.11 - 3.26)
25. In the last 2 weeks have you felt tired without a reason?				
No	13063	31	(0.2)	-
Yes (positive)	4722	50	(1.1)	-

* Odds ratio (95% confidence interval).

† Adjusted for sex and age.

Table 2. Specificity and sensitivity according to the cut-off points in the three Kihon Checklist conditions.

	Incidence of long-term care insurance certification			Specificity	Sensitivity
	n	Case	(%)		
The selected eight Kihon Checklist items					
3 points *				82.1%	92.6%
<3 points	14536	6	(0.0)		
≥3 points	3168	75	(2.3)		
4 points *				91.3%	82.7%
<4 points	16167	14	(0.1)		
≥4 points	1537	67	(4.2)		
The main 20 Kihon Checklist items					
8 points *				89.7%	82.7%
<8 points	15880	14	(0.1)		
≥8 points	1824	67	(3.5)		
All 25 Kihon Checklist items					
9 points *				85.1%	87.7%
<9 points	15074	10	(0.1)		
≥9 points	2630	71	(2.6)		

* Cut-off point.

Figures

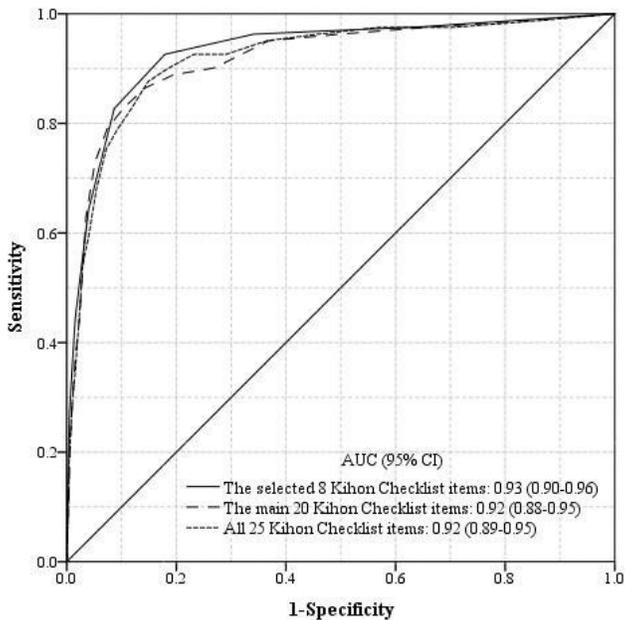


Figure 1

Area under the receiver operating characteristic curve in the three Kihon Checklist conditions for incidence of long-term care insurance certification (n = 17785).

Supplementary Files

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- [Questionnaire.docx](#)